Hypersonic Facilities

8-Foot High-Temperature Tunnel

This combustion-heated, blow-down-to-atmosphere tunnel at LaRC duplicates flight enthalpies at hypersonic conditions Mach 4 to 7 and accommodates large air-breathing propulsion systems and Thermal Protection System components. Tests of note include a Pratt & Whitney and U.S. Air Force test on the Ground Demonstrator Engine No. 2 (GDE–2) to better understand how test conditions influence the internal/external profile shapes of the engine and to document in detail any changes to its form. This landmark test also successfully demonstrated for the first time the use of a closed-loop hydrocarbon-fueled scramjet propulsion system at hypersonic conditions.

Aerothermodynamics Laboratory

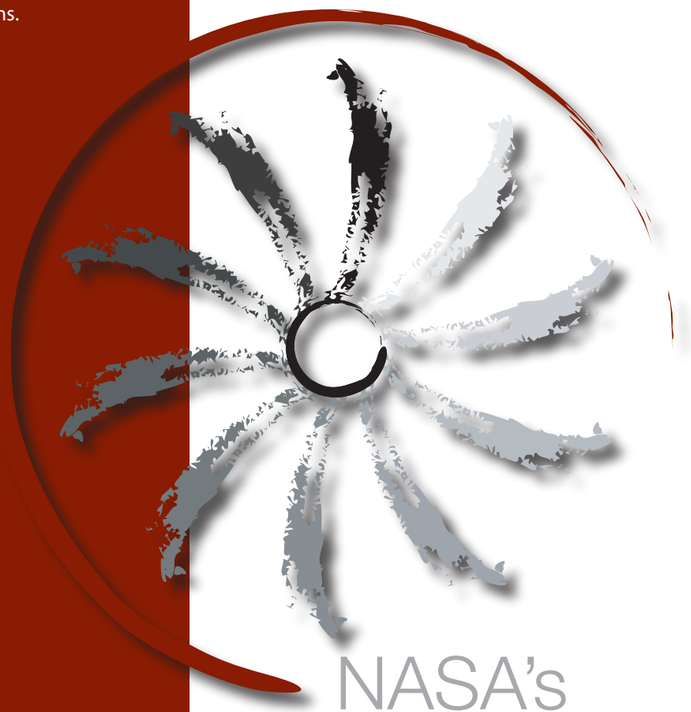
The Aerothermodynamics Laboratory at LaRC is a collection of three small, economical hypersonic tunnels used for basic fundamental flow physics research, aerodynamic performance measurements, and aero heating assessment. Many of the studies are aimed at screening, assessing, optimizing and benchmarking (when combined with computational fluid dynamics) advanced aerospace vehicle concepts. Collectively, these tunnels have contributed to many major hypersonic vehicle programs from the Apollo Space Program to the recent X–43A scramjet that flew at Mach 7 in March 2004 and Mach 9.6 in November 2004. These facilities also provide vital support to the development of NASA's CEV.

For additional information on ATP's ground-test facilities, please visit the following Web site:

http://aeronautics.nasa.gov/programs_atp.htm

B–1240
Oct 06

National Aeronautics and Space Administration



NASA's
Aeronautics Test Program
The Right Facility at the Right Time

www.nasa.gov

NASA's Aeronautics Test Program (ATP) is a model program

created to preserve the capabilities of the largest, most versatile, and ***comprehensive*** set of testing facilities in the nation.

With NASA facilities located at the Ames Research Center (ARC) in Mountain View, California, the Glenn Research Center (GRC) in Cleveland, Ohio, and the Langley Research Center (LaRC) in Hampton, Virginia, the ATP offers government, corporations, and institutions a wide range of experimental test services that reflect 60 years of unmatched aerospace test history. The ATP maintains a nationwide team of highly trained and certified staff, whose backgrounds and education encompass every aspect of aerospace testing and engineering.

Regardless of the test requirements, NASA's ATP can provide its clients with test results of unparalleled superiority.

FACILITY SPECIFICATIONS

	Speed	Reynolds number, per foot
11-Foot Transonic Unitary Plan Facility	0.20 to 1.45 Mach	0.30 to 9.6×10^6
National Transonic Facility	0.1 to 1.2 Mach	4 to 146×10^6
Transonic Dynamics Tunnel	0.1 to 1.2 Mach	0.30 to 3×10^6 and 0.2 to 10×10^6
8-Foot High-Temperature Tunnel	4, 5, and 7 Mach	0.30 to 5.1×10^6
9- by 15-Foot Low-Speed Wind Tunnel	0 to 0.20 Mach	0 to 1.4×10^6
14- by 22-Foot Subsonic Tunnel	0 to 0.3 Mach	0 to 2.1×10^6
20-Foot Vertical Spin Tunnel	0 to 85 ft/s	0 to 0.15×10^6
4-Foot Supersonic Unitary Plan Wind Tunnel	1.5 to 2.9 and 2.3 to 4.6 Mach	0.5 to 6×10^6 and 0.5 to 11×10^6
Icing Research Tunnel	50 to 395 mph	—
10- by 10-Foot Supersonic Wind Tunnel	0 to 0.4 and 2.0 to 3.5 Mach	0.1 to 3.4×10^6 (closed-loop) and 2.1 to 2.7×10^6 (open-loop)
Aerothermodynamics Laboratory	6 and 10 Mach	0.05 to 0.7×10^6, 0.2 to 2.2×10^6, and 0.5 to 8.0×10^6
8- by 6-Foot Supersonic Wind Tunnel	0.25 to 2.0 and 0.0 to 0.1 Mach	1.7 to 4.8×10^6
9- by 7-Foot Supersonic Wind Tunnel	1.55 to 2.55 Mach	0.50 to 5.7×10^6

Propulsion Systems Laboratory

The Propulsion Systems Laboratory (PSL) at GRC is a full-scale altitude engine test facility for air-breathing propulsion systems research and development. The PSL can accurately create temperature and pressure inlet conditions that propulsion systems experience in high-speed, high-altitude flight. Of the two test chambers, PSL–3 is used primarily for all facets of advanced aircraft research. PSL–4 incorporates a high temperature and pressure inlet plenum that meets the needs of high-speed and high-altitude propulsion system research for high-performance aviation and access to space applications. The PSL uses specialized systems to investigate these future propulsion systems, including liquid and gaseous fuels, multiaxis thrust measurements, and exhaust vectoring and collection.

Subsonic Facilities

9- by 15-Foot Low-Speed Wind Tunnel

The 9- by 15-Foot Low-Speed Wind Tunnel at GRC has nationally recognized capabilities to evaluate the aerodynamic performance and acoustic characteristics of fans, nozzles, inlets, and propellers. The tunnel can simulate takeoff, approach, and landing in a continuous subsonic flow wind tunnel environment including the investigation of hot gas re-ingestion of short takeoff and vertical landing (STOVL) concepts. The acoustically treated test section and microphones linked to a dynamic data system allow state-of-the-art acoustic measurements to frequencies as low as 250 Hz for research in reducing aircraft noise. Recent programs supported in this facility include the High-Speed Civil Transport, the Advanced Tactical Fighter, as well as the General Electric Aircraft Engines (GEAE) next-generation (GEnx) engine.

14- by 22-Foot Subsonic Tunnel

The 14- by 22-Foot Subsonic Tunnel at LaRC typically performs conventional performance testing for fixed-wing and rotorcraft configurations over a wide range of takeoff, landing, cruise, and high angle-of-attack conditions. However, this versatile facility can easily be reconfigured for acoustic, tethered free flight, forced oscillation (dynamic stability), and motor sports testing as well. The 14- by 22-foot tunnel also has the flexibility to test in either closed (walls, ceiling, and floor) or open (floor only) test section configurations. Recent upgrades to the facility automation system and fan motor (from 8000 to 12 000 hp) have greatly improved efficiency and capability. Major clients include the Department of Defense and aircraft manufacturers such as Boeing, Lockheed Martin, and Northrop Grumman.

20-Foot Vertical Spin Tunnel

The 20-Foot Vertical Spin Tunnel at LaRC is the only wind tunnel in the Western Hemisphere configured for free-spin tests using the dynamically scaled model technique. This unique capability is used to significantly reduce risk during airplane flight tests by identifying potential spin modes, control techniques required for spin recovery, and spin chute size requirements. Other capabilities include static force and moment, surface pressures, rotary balance, and forced oscillation measurements. Recent tests include free-spin testing of a Generic Transport Model (GTM), rotary balance tests of the ARES Mars Airplane configuration, and free-fall dynamic stability tests of a lunar sample return atmospheric entry capsule. These are just a few of the projects conducted to support the vital missions of NASA, Federal agencies, and industry.

Icing Research Tunnel

While there are numerous wind tunnels worldwide, the Icing Research Tunnel (IRT) is a rare and unusual facility located at GRC. Currently, the IRT is the U.S.'s largest refrigerated wind tunnel, devoted to investigating the myriad issues of aircraft icing. The tunnel simulates natural icing conditions to test the effects of in-flight icing on various aircraft components and scale models. The goal of the IRT is to replicate the Federal Aviation Administration (FAA) aircraft icing certification standards contained in the Federal Aviation Regulation (FAR) Part 25, appendix C. These tests reflect NASA's goals of assuring operational safety and advancement of critical aeronautics technologies to provide safer air transportation.

Transonic Facilities

11-Foot Transonic Unitary Plan Facility

The Unitary Plan Facility at ARC is an 11-foot transonic facility long known as a "workhorse" for the United States aeronautics industry. This facility has been used in the development of virtually every domestically produced commercial transport and military fixed-wing airframe since the 1960s. The 11-foot facility is used extensively for airframe development and aerodynamic studies and has played a vital role in every manned space-flight program, including NASA's Crew Exploration Vehicle (CEV). A major test series in support of the exploration mission is testing parachutes for future unmanned probes to Mars.

National Transonic Facility

The National Transonic Facility (NTF) at LaRC is a large transonic, cryogenic, and closed-circuit pressure tunnel that provides the highest Reynolds number testing capability in the world. The NTF can use either air or cryogenic nitrogen as the test gas, depending on client testing requirements. In the cryogenic mode, the NTF can match and selectively isolate Mach number, Reynolds number, and aeroelastic effects to accurately determine and understand vehicle performance. The facility provides testing and configuration aerodynamics validation for both full- and half-span models for existing and new vehicle concepts.

Transonic Dynamics Tunnel

The Transonic Dynamics Tunnel (TDT) at LaRC is the world's premier wind tunnel for testing large aeroelastically scaled models at transonic speeds. TDT investigations include tests of a NASA/Boeing Modern Transport to obtain steady and unsteady pressures on a wing and nacelle at transonic conditions, testing a Smart Vehicle Configuration to demonstrate the aerodynamic effectiveness of minibump control effectors, and a test of the CEV Dynamic Model to measure dynamic-pitch damping data. Additionally, a major project with the Defense Advanced Research Projects Agency (DARPA), Lockheed Martin, and NexGen focused on the development of Morphing Aircraft Structures (MAS) vehicles that undergo radical shape change to optimize performance in different flight regimes.

Supersonic Facilities

9- by 7-Foot Supersonic Wind Tunnel

The 9- by 7-Foot Supersonic Wind Tunnel at ARC, which shares the drive line with the 11-foot tunnel, has also been used extensively in the development of virtually every domestic fixed wing airframe that operates in supersonic regimes and has played a critical role in space exploration. This facility has provided ascent and reentry aerodynamic data for every NASA-designed, manned space-flight program, including the space shuttle and NASA's Constellation Program. The facility is also slated to test parachutes for future unmanned probes to Mars.

4-Foot Supersonic Unitary Plan Wind Tunnel

The Unitary Plan Wind Tunnel (UPWT), one of LaRC's core facilities, is a versatile, heavily utilized wind tunnel capable of supporting basic fluid dynamics research as well as applied aerodynamic research. This facility, which is utilized by NASA, DOD, and industry customers, contributes significantly to the development, assessment, and optimization of advanced aerospace vehicle concepts. The facility is utilized in support of major research programs such as Hyper-X (X43), X–43C, JSF, DARPA QSP, CEV, and Crew Launch Vehicle (CLV). UPWT contributions include both database development during the configuration design screening process, a first phase in configuration selection for a particular mission, and benchmarking the aerodynamic and aerothermodynamic configuration information for the selected mission concept. The UPWT, which is the only large operational supersonic tunnel at LaRC, is critical to LaRC's and NASA's mission.

8- by 6-Foot Supersonic Wind Tunnel

The 8- by 6-Foot Supersonic Wind Tunnel at GRC provides researchers the opportunity to test aerodynamic and propulsion models at subsonic, transonic, and supersonic speeds from Mach 0.25 to 2.0. Specialized support systems, a variety of research test hardware, and a calibrated test section support the development of aircraft, launch vehicles, and their components. Traditional tests include vehicle force and moment, inlet airframe integration, sonic boom mitigation, and inlet performance. The 8- by 6-foot tunnel has supported major programs such as the Advanced Turboprop, the National Aerospace Plane, the Advanced Tactical Fighter, the Joint Strike Fighter, the High-Speed Civil Transport, and the space shuttle.

10- by 10-Foot Supersonic Wind Tunnel

The 10- by 10-Foot Supersonic Wind Tunnel at GRC is a dual-cycle wind tunnel that operates either as a closed-loop (aerodynamic cycle) or open-loop (propulsion cycle) facility, reaching test section speeds of Mach 2.0 to 3.5. The tunnel can test supersonic aerodynamic and propulsion components such as inlets and nozzles, integrated propulsion systems, full-scale jet and rocket engines, and launch vehicle concepts. It provides continuous operation across the speed and altitude ranges, offering users greater flexibility and productivity during testing. The 10- by 10-foot tunnel has made contributions to the space shuttle, the High-Speed Civil Transport, the National AeroSpace Plane, the Joint Strike Fighter, and to the advancement of fundamental supersonic propulsion technology.